N I S

Nonproliferation and International Security

1998

Los Alamos
NATIONAL LABORATORY

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Nonproliferation and International Security

The proliferation of weapons of mass destruction (nuclear, biological, and chemical) is today widely recognized as the most serious threat to the security of the United States since the end of the Cold War. In October 1993, the Nonproliferation and International Security (NIS) Division was established at Los Alamos National Laboratory to respond to this threat. Our mission—*to deter, detect, and respond to proliferation*—is a major component of the Laboratory's mission *to reduce the global nuclear danger.*

To accomplish this mission requires the dedicated efforts and talents of some of our best and brightest scientists and engineers working in multidisciplinary teams on highly complex problems. Many of our people have advanced degrees in atmospheric and space sciences, astrophysics, nuclear physics, computer sciences, and engineering of all kinds, and this is only a partial list of the skills we need to do the job. Because our work is science-based, we work with universities and other research laboratories around the world. Because we need the best technology available, we work with some of the very best high-technology companies. Most of all, we derive the satisfaction that comes from accepting the challenge and producing unique products that make a difference to the safety and security of everyone. The men and women of NIS are proud to play a major role in reducing the global danger.

I hope you will take time to browse through this brochure and get to know us better. If you have questions or comments, I would like to hear from you.

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Nonproliferation and International Security (NIS)

NIS Role Within the Laboratory Mission

The end of the Cold War, the collapse of the Soviet Union, and the changing world political structure have mandated changes in the Los Alamos National Laboratory mission. During the Cold War, the Laboratory's work enabled nuclear deterrence. Now, after the Cold War, the mission to "Reduce the Global Nuclear Danger" is no less compelling. As in the past, the Laboratory is approaching the new challenges from a foundation of great science. That approach relies on the Laboratory's eight core technical competencies and builds on associations with civilian national missions, conventional defense, and industrial partnerships.

In the context of the Laboratory's mission, Nonproliferation and International Security (NIS) Division continues to lead national and international efforts to secure weapon-usable nuclear materials globally, especially in the states of the former Soviet Union. Our efforts in Test Ban Treaty monitoring and associated research resulted in the launch in fiscal year 1997 of the largest total number of spacecraft-borne sensors for a single year in Los Alamos history. Technical staff in NIS Division continue to lead national efforts to analyze foreign nuclear weapon capabilities in all nuclear-capable states.

NIS Division and Programs, in collaboration with other Laboratory divisions and programs, play a leadership role in consolidating and focusing Laboratory capabilities on the control of nuclear materials and on countering not only nuclear, but also biological and chemical weapons of mass destruction. NIS is leading intra-laboratory working groups on the Comprehensive Test Ban and Strategic Arms Reduction Treaty (START) III arms control initiatives and will support new Laboratory efforts that respond to new administration initiatives in environmental security and hard-target defeat.

NIS Vision

Our vision is a world with reduced nuclear dangers, as well as other threats to US and international security, through excellence in science and technology.

NIS Mission

Our mission is to develop and apply preeminent science and technology capabilities to deter, detect, and respond to proliferation of weapons of mass destruction and to ensure US and international security.

NIS Objectives

We are pursuing five strategic objectives to accomplish our mission and thereby realize our vision.

- Deter threats to domestic and international security.
- Detect and assess threats to domestic and international security.
- Respond to domestic and international security threats.
- Excel in science and technology.
- Ensure an environment that nurtures, supports, and rewards people working to accomplish our challenging mission.

NIS Organization

NIS is unique at Los Alamos National Laboratory as both a program directorate and line division. As shown in the chart on the next page, three program managers support the NIS Program Director in managing the NIS Program. Typically, about 75% of these program funds are expended in NIS Division, and the remainder throughout the Laboratory. Other major program elements include NASA programs and a Laboratory center, the Center for International Security Affairs.

The line segment of NIS includes nine technical groups and two facility management units. The nine groups typically obtain about 75% of their funding through NIS programs, and the remainder from supporting technical activities in other divisions. Thus the total funds expended by NIS groups are nearly equal to the total funds received by NIS programs, but about a quarter of each involves other Laboratory organizations. As the chart on the next page illustrates, NIS contributes to all the core competencies of the Laboratory.

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NIS is unique in the Laboratory as both a program and line organization.

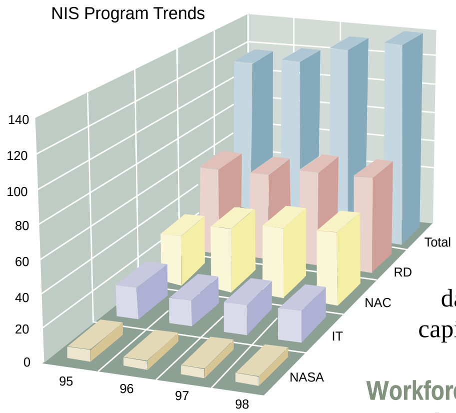
Program and Research Focus Areas

NIS has Laboratory-wide responsibility for four principal focus areas: nonproliferation and arms control (NIS/NAC); technology research and development (NIS/RD); international technology (NIS/IT); and NASA research programs. The first three areas represent the essence of the NIS programmatic mission. Each is described in the next few pages. Major NASA activities are synergistic with our mission and are included in the group profiles.

NIS scientists and engineers support these programs through a spectrum of research activities, ranging from applied research dictated by program needs, to exploration of fundamental natural phenomena. Additional research focus is provided by the Laboratory Directed Research and Development (LDRD) competency development thrusts. Two thrusts have been awarded to NIS: Remote Sensing Science and Advanced Nuclear Measurements Science Competency Development.

Laboratory Core Competency	NIS-1	NIS-2	NIS-3	NIS-4	NIS-5	NIS-6	NIS-7	NIS-8	NIS-9
1. Theory, Modeling, and High-Performance Computing	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Complex Experimentation and Measurement	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Nuclear and Advanced Materials					✓	✓	✓	✓	✓
4. Nuclear Weapons Science and Technology	✓	✓	✓	✓	✓	✓	✓	✓	✓
5. Analysis and Assessment	✓	✓		✓	✓	✓	✓	✓	✓
6. Earth and Environmental Systems	✓	✓	✓	✓	✓		✓		
7. Bioscience and Biotechnology				✓					✓
8. Nuclear Science, Plasmas, and Beams	✓	✓	✓	✓	✓	✓	✓	✓	✓

NIS contributes to all of the core competencies of the Laboratory.

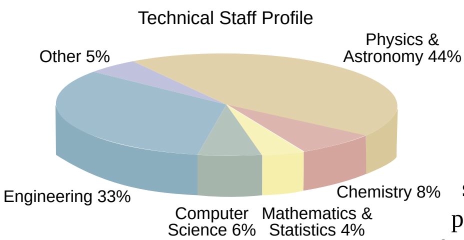


Budget

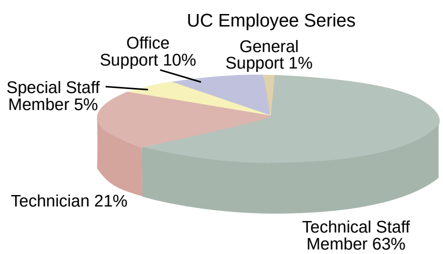
The total NIS budget in fiscal year 1997 was $133 million and is estimated to be $138 million for fiscal year 1998. Changes within the individual major programs are visible in the bar graph and reflect changes in funding agency priorities. The data include both operating and capital funds.

Workforce

Meeting the NIS mission objectives demands a multifaceted workforce that represents a spectrum of skills and capabilities. The total workforce consists of about 700 full-time employees. About two-thirds of the NIS workforce are regular University of California (UC) employees. Nearly a fourth are postdoctoral appointees and students who contribute fresh perspectives and the latest in formal skills. The remainder includes contract employees, Laboratory associates and affiliates, guest scientists, limited-term appointees, and visiting staff members.



Technical staff members (TSMs) comprise the largest share of NIS UC employees. Seven current NIS TSMs and six NIS Laboratory Associates have achieved the rank of Laboratory Fellow, a distinction that recognizes exceptional contributions to Laboratory programs and associated science. A significant number have been recognized by professional associations, or serve in association leadership positions. Physics and engineering continue to be the predominant disciplines among NIS staff, though other fields, such as those related to computational capabilities, are becoming increasingly important.

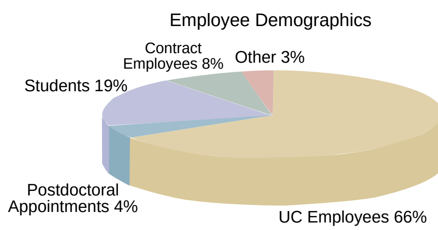


Unique NIS Contributions to National Security

The scope of the NIS mission and the breadth of its capabilities present division members with opportunities for unusual contributions and achievements. A sampling of these includes the following: leading the inter-laboratory working group that deals with nuclear material control programs in the former Soviet Union; serving on the staff of federal agencies, including the Department of Energy (DOE), Department of Defense (DoD), National Security Agency (NSA), and Central Intelligence Agency (CIA); supporting the Comprehensive Test Ban Treaty negotiations; serving as a NASA astronaut; serving in leadership positions for the Institute of Nuclear Materials Management; and serving on boards and teams for federal agencies.

Commitment to the Future

Tomorrow's technological challenges in assuring our national security will require ever-increasing scientific and technical talent, creativity, and ingenuity. NIS believes in the advantages of a diverse workforce and aggressively pursues recruitment of the best and the brightest recent graduates, postdoctoral fellows and associates, and graduate and undergraduate students. In the past year, 27 new Ph.D. graduates, including one Oppenheimer Fellow, pursued postdoctoral studies under the auspices of NIS. Our student programs in fiscal year 1997 included 45 graduate research associates and 83 undergraduate employees. In fiscal year 1997, NIS recognized student contributions by awarding scholarships to 25 of its student employees. These new scholarships are funded by proceeds from royalties accrued by the division from patents held by the division staff.



Nonproliferation and Arms Control (NIS/NAC)

Program Manager: **James W. Tape**
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Los Alamos National Laboratory Nonproliferation and Arms Control (NAC) programs are focused on reducing the threat to US national security posed by weapons of mass destruction. Nuclear, chemical, or biological weapons constitute a threat to the US military, our allies, and to our populace. We are concerned with proliferation by nations and with the potential spread of these lethal technologies to subnational terrorist groups. We also want to ensure that the superpower nuclear arms reductions are irreversible, and that we will never see a resumption of the nuclear arms race. Preventing the spread of weapons of mass destruction materials, technology, and expertise; detecting proliferation worldwide; and reversing proliferation are the central elements of our approach.

The NAC programs provide key technologies and technical expertise to enable this essential national-security mission. Activities carried out in support of US policies include

1. assisting in the negotiation of treaties for arms control, nuclear testing restrictions, and fissile-material production limitations;
2. evaluating export control requirements;
3. developing instruments and systems to improve control of nuclear materials in the US, in the former Soviet Union, and under international safeguards through the International Atomic Energy Agency (IAEA);
4. implementing nuclear material protection, control, and accounting (MPC&A) programs in the former Soviet Union;
5. addressing the issue of nuclear smuggling; and
6. providing training for inspectors involved in the implementation of various nuclear material control agreements.

The technical core of the NAC programs is the development of means to control nuclear materials and the spread of nuclear technologies. These technical systems (domestic and international nuclear materials safeguards, MPC&A for Russia and the other new independent states of the former Soviet Union, and nuclear export controls) are among the few remaining barriers to nuclear proliferation. With this technology base and the broad technical expertise of all of Los Alamos, we also provide technical support to the US nonproliferation and arms-control policy development and implementation.

NAC helps to implement control and accounting systems in the former Soviet Union that are designed to secure nuclear material from theft or diversion.

In addition to its long-standing involvement in and support of the Nonproliferation Treaty and the IAEA, NIS/NAC is currently involved in preparations for implementation of the Comprehensive Test Ban Treaty, START III, the Fissile Material Cutoff Treaty, the Bilateral Agreement with the Russian Federation concerning the cessation of the production of plutonium for weapons, Nunn-Lugar agreements to provide safe storage of Russian fissile materials, the US/Russia/IAEA Trilateral Initiative for verification of fissile material, and numerous Lab-to-Lab arrangements to improve Russian and Chinese nuclear-material security.

The key thrusts for NAC programs are

- Russian fissile materials,
- US fissile materials,
- nuclear safeguards in Japan/Korea/China-Asia,
- export controls,
- Comprehensive Test Ban Treaty implementation,
- strengthened IAEA safeguards (Programme 93+2),
- Strategic Arms Control/Dismantlement–irreversible arms reductions, and
- counter smuggling.

Research and Development (NIS/RD)

Program Manager: **David J. Simons**
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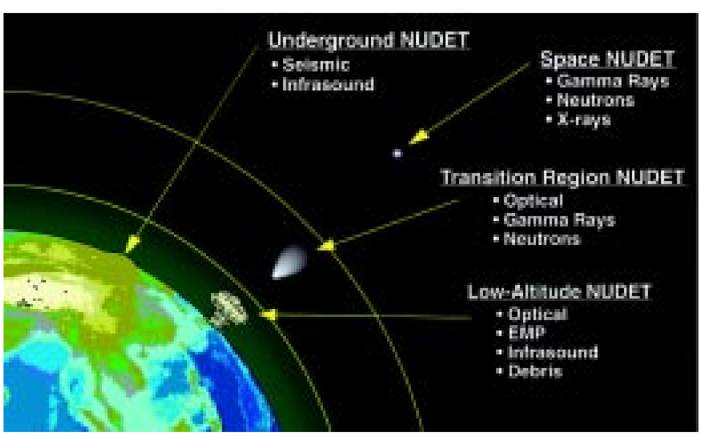
NIS Division supports US nonproliferation and national security policies by developing sensors as well as analytical and modeling capabilities for detecting and characterizing proliferation. Proliferation in this context includes testing of weapons of mass destruction and the related production of materials and equipment. The Laboratory is carrying out research and development for remote-sensing monitoring and assessment technologies for detecting and identifying emanations, effluents, and other distinctive signatures of potential nuclear weapons research and development efforts. Members of the defense community, including the DOE, DoD, the Department of Justice, and the Intelligence Community, apply these technologies in both overt and covert configurations and in local, regional, and worldwide deployments.

Los Alamos is a leader in providing research and development support to the nation's nonproliferation program. Research and development to support proliferation detection is an NIS strategic initiative. This research and development includes identification and cataloging of signatures for proliferation activities and development of sensors capable of detecting and characterizing these signatures. Instrumentation will be deployed on space-, air-, sea-, and land-based platforms. Current research and development projects, such as Chemical Analysis by Laser Interrogation of Proliferant Effluents (CALIOPE), Multispectral Thermal Imaging (MTI), and Remote Ultra-low Light Level Imaging (RULLI), are investigating a broad spectrum of potentially useful techniques.



NIS is developing technologies to verify the Comprehensive Test Ban Treaty.

NIS performs nonproliferation and treaty verification research and development for the DOE's Office of Research and Development (NN-20), which currently sponsors the largest US research and development program supporting US national nonproliferation and arms control policy objectives. Principal task areas include

- on-site systems primarily for monitoring nuclear materials and facilities;
- emergency response to the transnational use of chemical and biological weapons;
- nuclear test detection for verifying compliance with nuclear testing treaties; and
- advanced systems and technologies for detecting the proliferation of weapons of mass destruction.

Verifying compliance to a comprehensive ban on nuclear testing requires significant improvements to existing verification systems; such research and development is another NIS strategic initiative. The Comprehensive Test Ban Treaty is directed not only toward acknowledged nuclear weapons states but also toward those other nations and organizations with interests in developing a nuclear weapons capability. The Laboratory program is attempting to develop monitoring systems capable of detecting all potentially significant nuclear tests, even at very low yields. Satellite-based systems will continue to be the backbone of the monitoring system for tests in the atmosphere and in space. Follow-on systems to the existing Global Positioning System (GPS) and Defense Support Program (DSP) satellite systems are being developed to take advantage of modern sensor technology to achieve improved sensitivity at lower weight and power levels. Through such programs as Fast On-orbit Recording of Transient Events (FORTÉ), our recently launched satellite-based experimental test bed for electromagnetic pulse detection, emphasis is being placed on the use of small, more efficient and less expensive satellite systems. In the area of underground testing, the emphasis for monitoring will be on the detection of small evasively tested devices. These types of tests must be detected by worldwide seismic and hydro-acoustic systems, which are undergoing significant capability upgrades in preparation for monitoring the Comprehensive Test Ban Treaty. NIS will continue to play a major role in the required ongoing evolution of all of these systems as they are brought up to the required capabilities to satisfy this new monitoring regime.

International Technology (NIS/IT)

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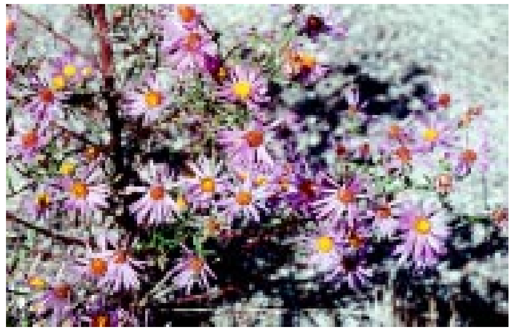
The growing worldwide inventories of special nuclear materials, the technical simplicity involved in producing biological and chemical agents, the increased access to missile technology for delivery systems, and increases in regional strife have all contributed to the problem of proliferation of weapons of mass destruction. The problem is further complicated by the specter of subnational terrorists employing these weapons or of organized international criminals trafficking in nuclear materials and nuclear weapons components. Information-based attacks on critical national infrastructures are also of increasing concern. Moreover, rapid advances on all technology fronts have increased the likelihood of a "technological surprise." To guard against such happenings, Los Alamos National Laboratory, under the auspices of DOE, continues to vigorously pursue a program that provides technical assessments of these critical issues in support of national policy makers.

Nonproliferation and International Security Division International Technology (NIS/IT) programs draw upon all-source data, the nuclear weapons expertise, and the multidisciplinary capabilities of the Laboratory, which all combined provide intelligence analysis under the auspices of the DOE/ Nonproliferation and National Security (NN). For the DOE Office of Energy Intelligence (NN-30), these projects provide technical estimates of foreign nuclear weapons, the related infrastructure, and the underlying science and technology base and capabilities. Laboratory scientists provide assessments of nuclear weapons technology, materials production, nuclear proliferation potential, and dual-use technologies (i.e., technologies that are important to national defense but are beneficial in peaceful pursuits). In order to enhance the effectiveness of our analysts, NIS/IT has developed new methodologies for acquiring, cataloging, and analyzing the large volumes of all-source data that are an essential part of a first-rate assessment.

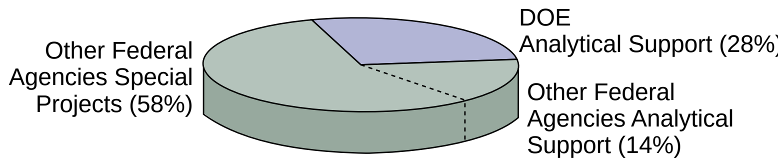
For other federal agencies, projects in NIS/IT tap into the interdisciplinary competencies resident at the Laboratory to develop specialized hardware and tailored application of extant capabilities.

From explosives to pulsed power to information security to materials science, new technologies and new capabilities are being developed through NIS/IT to help deter, detect, and respond to the threat of proliferation of weapons of mass destruction and other threats to our national security. Through NN-30, the mission to deter, detect, and respond includes

- technical support developing innovative options for mitigating new security threats, including those associated with the worldwide proliferation of advanced conventional weapons;
- assessments of the relative impact of arms control treaties on foreign nuclear weapons programs;
- advanced computational and analysis capabilities that provide rapid assessment of options for responding to evolving threats, including the capability to model the consequences of those response actions;
- a range of credible, high-confidence methods for locating, characterizing, and disabling these weapons;
- technologies that provide enhanced capabilities to commanders, special mission units, or law enforcement agencies;
- creative technical solutions to otherwise "intractable" national security problems;
- US law enforcement community access to appropriate Laboratory technical capabilities to counter criminal activities and terrorism with real-time access to Laboratory resources to support on-site reaction teams; and
- intelligence-based evaluations of nuclear smuggling and illicit trafficking in nuclear technologies and materials.



NIS/IT makes available to the Intelligence Community advanced technologies from across the Laboratory. As an example, several pages of text are embedded in this picture (US Patent Number 5,659,726).



NIS/IT provides support and analysis to the Intelligence Community on issues relating to foreign weapons of mass destruction capabilities and is the threshold to the entire Laboratory for special projects.

Center for International Security Affairs

The Center for International Security Affairs (CISA) at Los Alamos National Laboratory was created in January 1995 to coordinate the Laboratory's growing interactions with Russia's newly independent states, China, and other countries with programs involving weapons of mass destruction. CISA is responsible for identifying, developing, coordinating, and representing cooperative technical projects between Los Alamos scientists and their counterparts in sensitive institutes in sensitive countries. CISA is responsible for all programs specifically created for work in these countries, including the DOE effort in nuclear materials control, our participation in the International Science and Technology Center and the Science and Technology Center in the Ukraine, and the Los Alamos component of the Initiatives for Proliferation Prevention Program. In addition, CISA oversees other programs to insure that all Los Alamos activities abroad are consistent with US objectives and policy, and are coordinated with similar US government programs.

Weapons of mass destruction and especially nuclear weapons represent the only strategic threat to the United States. The principal objective of the programs coordinated by CISA is to actively reduce the threat of weapons of mass destruction through collaborative projects with colleagues overseas. In the former Soviet Union, CISA has the goal of preventing proliferation of weapons materials and expertise.

Vehicle portal monitors like this one were installed at VNIITF with Los Alamos assistance to detect nuclear material as vehicles pass through access gates when leaving nuclear facilities.

Nuclear material protection, control, and accountability (MPC&A) is by far the largest of the programs overseen by CISA. As a lead laboratory for this effort, Los Alamos works closely with other US laboratories and our counterparts in Russia. Building on a foundation of trust and cooperation established through scientific collaboration between US and Russian weapons laboratories since 1992, the DOE in April 1994 initiated a new approach to MPC&A cooperation: the Lab-to-Lab MPC&A Program. Scientists and engineers at the laboratories, working under the guidance of their governments, plan and carry out the work. This approach has proved very productive and expeditious in highly technical fields such as MPC&A. In 1995, a Presidential Decision Directive declared MPC&A one of the top national security objectives. The program has expanded to include 41 Russian institutes, facilities or regulatory projects, and another 13 facilities in other former Soviet Union states.

The All Russian Scientific Institute of Experimental Physics (VNIIEF), one of two Russian nuclear weapon design laboratories, was one of the first Russian facilities to participate in the MPC&A program. The best Russian and US MPC&A technologies and methods were combined in an extensive demonstration facility and subsequently implemented at several research and production facilities within VNIIEF. These technologies are now experiencing widespread implementation throughout the Russian nuclear weapons complex. The system includes stringent methods for entry control, nondestructive assay measurements, item control functions, and inventory verification. The US provided equipment and technical support as its part of the collaboration, while the Russians provided Russian equipment and methods.

At the Kurchatov Institute, a leading designer of reactors, a basic MPC&A system was installed where experiments with highly enriched uranium were conducted. As a direct result of the US-Russian collaboration, this area now has effective physical protection and computerized nuclear material accounting systems. One facility at the Institute for Physics and Power Engineering containing over 3 tons of special nuclear material was selected as the site for another MPC&A cooperative effort. A combination of US and Russian technologies and methods was installed in 1995, including

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vehicle and pedestrian monitors to detect nuclear materials concealed in vehicles leaving the site or persons exiting the building. The two largest nuclear material operations sites in the world (Tomsk-7 and MAYAK) are also now implementing advanced protection technologies.

Los Alamos also has extensive scientific interactions with VNIIEF and the All Russian Scientific Institute of Technical Physics (VNIITF). For example, as of the spring of 1996, we had conducted 18 major experiments in high-explosive pulsed power with VNIIEF. These experiments combine a considerable Russian lead in high-energy pulsed power with advanced Los Alamos diagnostics to do science that neither side could do on its own. Scientists who were previously involved in the development of nuclear weapons are now working on problems of fundamental scientific interest: a process we call Scientific Conversion.

The International Science and Technology Center in Moscow and the Science and Technology Center in Kiev were established by multilateral agreements as nonproliferation programs to fund civilian science and technology projects engaging scientists who have expertise in weapons of mass destruction and delivery systems. To date, the two science centers are funding over 550 projects for nearly $160 million involving over 20,000 highly qualified scientists and engineers. Hundreds of Los Alamos scientists participate in various aspects of the activities of these science centers, including proposal review and evaluation, collaboration on joint research, project monitoring, short- and long-term overseas assignments, and technical advice to the US government on the centers.

The Initiatives for Proliferation Prevention Program is aimed at redirecting the efforts of scientists who have been involved in weapons development. Its goal is to provide peaceful and profitable alternatives to weapons work through cooperative programs involving scientists and engineers in the former Soviet Union and in US national laboratories and industry. Los Alamos is a leading participant in the Initiatives for Proliferation Prevention. Most technical divisions at the Laboratory have ongoing project activities, and several cooperative research and development agreements (CRADAs) have been signed with industrial partners. Los Alamos is also one of the laboratories responsible for the design and implementation of the computer-based information processing network that links the laboratories and the industry participants in Initiatives for Proliferation Prevention, as well as related NIS programs.

Los Alamos is active in two joint US-Russian programs, one on plutonium disposition and a second on warhead dismantlement transparency. Under the aegis of the Joint US-Russian Plutonium Disposition Steering Committee, the first program's aim is to facilitate the conversion and disposition of plutonium from dismantled Russian warheads into a form suitable for ultimate disposition. The warhead dismantlement transparency program, functioning under the auspices of the US DOE, funds technical exchanges between US and Russian scientists to identify and evaluate technologies to increase our mutual transparency in warhead dismantlement.

CISA has its own building at Technical Area 66 in Los Alamos. It has facilities for meetings of up to 60 people and can host foreign collaborators for extended periods. As the principal point of contact at Los Alamos for interactions in the former Soviet Union, China, and elsewhere, CISA can assist Laboratory personnel in establishing appropriate scientific projects and can provide the US government and other organizations with information and advice on nuclear-related issues worldwide.

Russians from Arzamas-16 and Americans from Los Alamos National Laboratory work together in Ancho Canyon at Los Alamos to assemble an experiment to measure the properties of high-temperature superconductors.

Remote Sensing Science (RSS) – A Laboratory Thrust

Principal Investigator: Sig A. Gerstl
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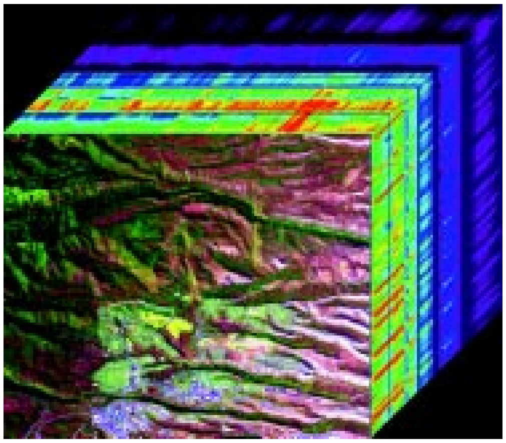

Hyperspectral image cube (with 224 spectral channels) from Advanced Visible and Infrared Imaging Spectrometer (AVIRIS) measurement over Los Alamos. Front image is in infrared near 870 nm. The yellow area is the town's golf course. Laboratory sites are in purple. Data were acquired from an altitude of 20 km.

Revolutionary advances in our understanding of processes affecting the earth and its atmosphere will result from the emerging interdisciplinary science of remote sensing. Los Alamos National Laboratory contributes to many phases of this scientific revolution. The Remote Sensing Science (RSS) thrust pulls these efforts together in an integrated team.

Remote sensing instruments have been improving rapidly. Ground-based light detection and ranging (LIDAR) instruments already provide time-resolved atmospheric aerosol images with sub-meter spatial resolution. The first space-based LIDAR recently flew on the Space Shuttle, and species-specific LIDAR capabilities are evolving rapidly. New satellite instruments providing images with hundreds to thousands of visible and infrared spectral channels, called imaging spectrometers, can reveal intricate details of the identity and state of observed substances. Data from such capabilities require computational models at new levels of complexity and physical sophistication. Los Alamos is involved in these instrument technologies and model developments through its nonproliferation and environmental stewardship programs and is developing a strong core competency through the RSS thrust.

1997 remote sensing measurements of emission plume chemical constituents at active Popocatepetl volcano near Mexico City. The Fourier Transform Infrared Spectrometer (FTIR) and Correlation Spectrometer (COSPEC) instruments are deployed side-by-side 10 km from the summit.

The RSS thrust builds on Los Alamos' strengths in visible and infrared spectral imaging and laser remote sensing (such as LIDAR) and our capability to develop new and innovative measurement and analysis techniques. We focus the thrust in three component areas: hyperspectral passive remote sensing, laser active remote sensing, and innovative new concepts. These components then feed an integrated approach to several "national-laboratory class" research issues. These efforts build on a large programmatic investment in instrumentation, modeling, data analysis, and interpretation.

Specific key research areas for the integrated approach of this thrust include the characterization of gases emanating from volcanoes and understanding physical processes of atmospheric transport. Currently, vulcanologists use laboratory analysis of collected gas samples as the primary means of measuring the composition of volcanic plumes. These samples are difficult to collect, require long delays for analysis, and can at best provide data at a single point in space and time. Valuable new information about the dynamic processes occurring before, during, and after an eruption have been determined from the active and passive remotely sensed data from measurements of the plume. Similarly, atmospheric scientists now rely on data collected by point sensors at fixed sites or on sondes. In contrast, our new LIDAR-based sensing instruments have been measuring three dimensional, time-resolved data of physical processes involved in energy transport, moisture, and momentum transfer, especially in the atmospheric boundary layer where turbulent mixing dominates.

Advanced Nuclear Measurements Science Competency Development – A Laboratory Thrust

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Los Alamos National Laboratory has been the lead laboratory for research and development related to nuclear materials measurements for 30 years. We have established the standards currently in use in the US, around the world, and adopted by the International Atomic Energy Agency (IAEA). At the end of the Cold War, hundreds of tons of inadequately protected and controlled weapons-usable nuclear materials challenged the safety and security of the world. Building on its experience, Los Alamos immediately responded to the challenge and led the DOE effort that has vastly improved the security of weapons-usable nuclear materials at more than 40 facilities in the former Soviet Union.

The future challenges include rapidly growing stocks of materials in civilian programs, particularly those in Japan and China; materials recovered from dismantled nuclear weapons in the US and Russia; and the residues and wastes left over from the production process. The DOE mission is shifting toward fissile material disposition, waste disposal and cleanup, interdiction of nuclear smuggling, and stabilization of process materials. In addition, proliferation concerns about material generated by the increasing use of commercial nuclear energy are becoming more predominant. These changes require significantly different measurement capabilities.

The purpose of this Laboratory Directed Research and Development (LDRD) thrust is to develop the scientific "building blocks" for the nuclear material measurement capability of the future. We have identified the following six specific scientific developments that will be necessary to fully address these measurement problems.

Sensitivity Analysis The purpose of this component of the thrust is to develop the modeling capabilities for the future control of nuclear material. This component will help select which future problems are the most important to target.

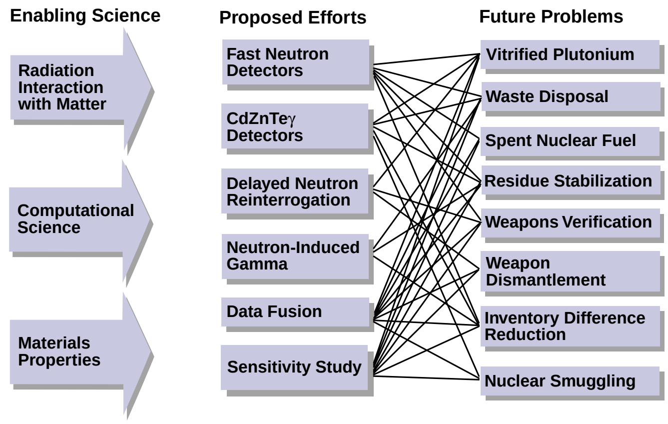
Data Fusion Data integration (fusion) is a promising approach for rapidly extending nondestructive assay capabilities, largely because it has not been exploited. The intent is to balance and combine several disparate measurements from different instruments into a single, better, assay value.

Advanced Gamma-Ray CdZnTe Semiconductor Detectors This research area will develop new room-temperature, medium-resolution, cadmium-zinc-tellurium (CdZnTe) detectors that will provide significantly higher resolution than sodium iodide (NaI) but with the same practical, room-temperature operation. The present difficulty with CdZnTe detectors is that response, resolution, and line shape vary between detectors and can depend on size and crystal properties.

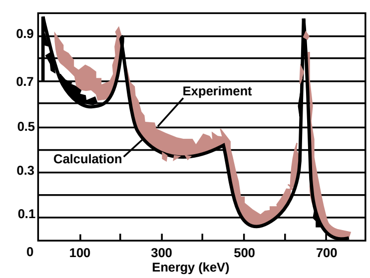
Short Die-Away-Time Neutron Detection A promising candidate for the next generation of neutron-detection systems is based on the boron-loaded plastic scintillator coupled to a bismuth-germanium (BGO) layer to reject gamma rays. By mixing the moderator (H) with the detection material (10B), one expects to obtain a detector with 3-ms die-away time and 50% efficiency.

Reduced-Bias Active Measurements by Delayed-Neutron Re-Interrogation We are developing a novel neutron interrogation method that has the potential for significantly mitigating the bias error in heavily shielded samples, called delayed-neutron re-interrogation. The principle is that a sample is interrogated with 14-MeV neutrons to penetrate the shielding material and induce fissions.

Neutron-Induced Gamma-Ray Signatures Neutron-induced gamma-ray analysis, also called prompt-gamma neutron-activation analysis (PGNAA) or thermal neutron analysis (TNA), is a method that we wish to both acquire and develop. The technique is somewhat mature; however, there are several significant gaps in the scientific information that have rendered it largely impractical for general nuclear materials measurement. The exciting possibility about this technology is that it can be combined with tomographic imaging of gamma rays and neutrons to provide a fully self-consistent solution to the distribution of material in a sample.



Schematic of the relationship between the future measurement problems and the specific scientific developments that we are proposing. Each solution depends on several, perhaps all, of the physics issues we have identified.



Comparison of measured and calculated spectra for CdZnTe detector. Calculated spectrum was developed from a full-physics model of the detector.

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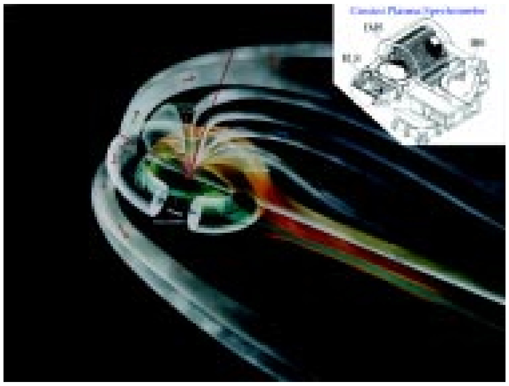
Space and Atmospheric Sciences (NIS-1)



This artist's rendition of the magnetosphere shows the orbits of two satellite constellations that carry NIS-1 nuclear detection instruments to monitor the atmosphere and space.

The Space and Atmospheric Sciences (NIS-1) group monitors the atmosphere and near-earth space for possible nuclear tests with satellite-borne particle and radio-frequency detectors. The techniques under development to detect proliferation activities use neural networks, buried power-line detection methods, tritium detectors, explosives detection, and neutron spectrometry. We also apply some of these techniques to the ground-based detection and characterization of nuclear materials for nonproliferation purposes.

NIS-1 supports the DOE's mission to verify nuclear test ban treaties by developing technologies capable of detecting clandestine nuclear tests and by monitoring nuclear weapons proliferation activities. NIS-1 has significant capability to design, build, and integrate space-based sensors, and then analyze the data collected by these sensors.

NIS-1 has built an international reputation by conducting scientific studies of the atmosphere, ionosphere, magnetosphere, and solar wind. Some of our current major programs in these areas are as follows:

- Plasma instruments for programmatic spacecraft at geosynchronous orbit, NASA/ESA Ulysses solar wind mission, and NASA's ACE solar wind mission
- Plasma and ion composition instruments for NASA/ESA Cassini mission to Saturn
- Blackbeard and FORTÉ radio frequency detectors for direct measurements of trans-ionospheric propagation of VHF signals from earth
- The MENA neutral atom imager for NASA's IMAGE spacecraft
- An ion composition instrument for NASA's New Millennium DS-1 mission to a comet
- International collaborative studies of lightning, including new discoveries in upward-propagating lightning
- Neutron, gamma-ray, and alpha-particle instruments for NASA's Lunar Prospector mission

NIS-1 has a very broad range of capabilities that support our programmatic and scientific missions, including the following:

Radio and ionospheric physics—Detection and analysis of transient radio bursts using space-based and ground-based detection

- Lightning measurements and theory
- Detection of transient ionospheric pulse pairs
- Trans-ionospheric and sub-ionospheric propagation studies
- 3-D electromagnetic wave propagation ray-tracing models with integrated ionospheric models, including the effect of the structured ionosphere
- Radio-frequency field experiments
- Ground-based electromagnetic pulse generator for spacecraft calibration
- Nuclear weapons effects in the atmosphere and space

Space physics—Instrumentation, analysis, and theory

- Space plasma physics
- Solar wind and solar-terrestrial physics
- Magnetospheric physics
- Planetary physics

Final inspection of the FORTÉ satellite prior to its successful launch from an Air Force Pegasus-XL rocket. FORTÉ, which stands for Fast On-orbit Recording of Transient Events, is a lightweight satellite designed to test technology to monitor compliance with arms control treaties. FORTÉ's instruments will detect, record, and analyze bursts of radio and optical energy arising from near Earth's surface.

Space and Remote Sensing Sciences (NIS-2)

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Deputy Group Leader: Vacant

The Space and Remote Sensing Sciences (NIS-2) group mission is to develop and apply remote sensing instrumentation to problems of national security and related sciences. Applications include nonproliferation, detection of nuclear explosions, safeguarding nuclear materials, climate studies, space sciences, and astrophysics. We also pursue new ideas in technologies and applications related to our mission.

Our specific capabilities are demonstrated in the following active applications (listed in approximate order of current funding).

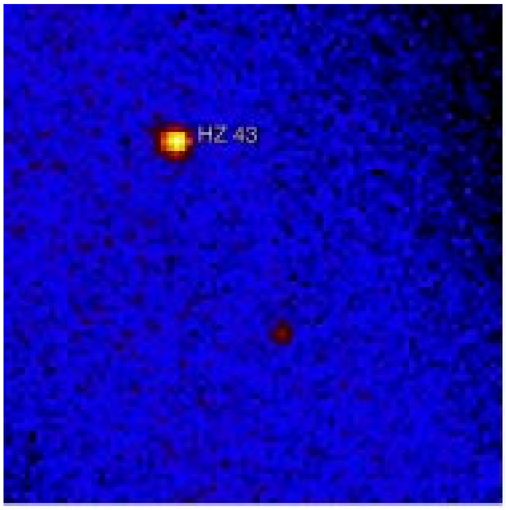
- Optical and infrared remote sensing on aircraft, satellites, and on the ground in support of nonproliferation and environmental missions. We concentrate on end-to-end modeling and analysis, calibrations, and innovative instrumentation. This work also links to the RSS thrust and to the Laboratory's new tactical goal in environmental security.
- X-ray, gamma-ray, neutron, and energetic particle diagnostics in support of our core treaty verification and related scientific missions.
- Magnetospheric physics and planetary exploration missions using technologies related to our programmatic activities for improved understanding of the solar/terrestrial system.
- Astrophysics, including theory, modeling, instrumentation, and data analysis. Our most recent addition is the on-site capability to measure optical counterparts to signals obtained by the satellite-borne instrumentation.
- Small satellite system design, operation, and related data analysis. The ALEXIS satellite is now in its fourth year of operation, significantly exceeding its design goals.
- Development of advanced technologies, including the Los Alamos solid-state optical refrigerator and various sensors and innovative instrumentation.
- Deployable adaptive processing systems to allow certain advanced data-analysis techniques associated with our instruments.

NIS-2 has about 50 professional staff, including Laboratory technical staff members, contractors, postdoctoral fellows, guest scientists, and technicians, as well as administrative support personnel.

We have a state-of-the-art optical and infrared calibration facility and significant collaboration with the National Institute of Standards and Technology in this area, including development of new transfer standards.

We have several pulsed x-ray sources, other radioactive sources, vacuum chambers (including a thermal vacuum capability), several well-equipped instrumentation laboratories, and extensive computational equipment (workstations, multiprocessor cluster, large data storage systems, etc.)

Our major customers are the DOE, NASA, and other US government agencies. We collaborate with a number of universities, industry, and other research organizations.



Portion of the Extreme Ultraviolet sky imaged by the ALEXIS satellite showing two bright sources separated by approximately eight degrees.

The combined x-ray dosimeter (CXD) instrument will fly on 24 Ground Positioning System (GPS) satellites to enhance x-ray monitoring capabilities in support of the Comprehensive Test Ban Treaty and to provide programmatic and scientific data on the magnetosphere.

Space Data Systems (NIS-3)

Group Leader: Earl R. Tech
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Deputy Group Leader: Stephen G. Blair

The FORTÉ team observing initial data from the FORTÉ spacecraft shortly after launch on August 29, 1997. NIS-3 was an integral part of the FORTÉ project, including developing payload and spacecraft software and establishing ground stations at Sandia National Laboratories and the University of Alaska, Fairbanks.

The Space Data Systems (NIS-3) group activities include developing real-time data acquisition and control systems, building and operating satellite ground stations, reconfigurable computing, development of remote monitoring systems, scientific and database programming, and maintaining multi-user open and secure distributed-computing environments. These efforts date from the Vela series of spacecraft in the early 1960s through a number of current DOE, DoD, and NASA missions. NIS-3 emphasizes consistent handling of data during the various phases of each experiment's life cycle and focuses on use of standards and commercial products, reuse of software, and development of central processing unit (CPU)-independent systems. NIS-3 works closely with other groups at the Los Alamos National Laboratory and in NIS, as well as other organizations including

- Sandia National Laboratories (data handling and software development);
- United States Air Force, including the 55th Space Weather Squadron (space environmental data), Air Force Space Command (satellite turn-on and early-orbit activities), and Air Force Technical Applications Center (analysis software); and
- Russian Federation laboratories, through the Lab-to-Lab program, including Arzamas-16 (Sarov), the Institute of Physics and Power Engineering in Obninsk, and the Siberian Chemical Combine in Seversk (facility monitoring systems).

NIS-3's areas of expertise and specific projects include

- Development of data-acquisition systems, based on a standard architecture, for use with ground, air, and space-based scientific experiments (RADEC, GPS, MTI, and CALIOPE)
- Management of all phases of software development for ground, air, and space-based instrumentation systems, including integration and test, flight, ground control, and scientific data analysis
- Small satellite activities, including development of flight software, ground stations, integration and test, and satellite operations (ALEXIS and FORTÉ satellites)
- Development and operation of real-time data links and associated processing of on-orbit satellite data (RADEC and GPS)
- Facility monitoring systems, including an Internet-based real-time digital video event detection system with global remote-monitoring capability
- Support for a wide range of computer platforms, operating systems, programming languages, and tools in a heterogeneous distributed-computing environment

Real-time digital video event detection is used in facility monitoring, as shown in the sequence of images. From left to right, the images show the initial state of the area under surveillance, an event that changes the initial state, and the resulting differences in the scene, showing what has been changed.

Space Engineering (NIS-4)

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Deputy Group Leader: **Steve Wallin**

The Space Engineering (NIS-4) group is a science and engineering group that develops custom sensors, instrumentation, and systems for applications requiring advanced monitoring, detection, and assessment technologies.

The emphasis of the group is to develop high-quality, reliable instruments and systems for unattended, stable, long-term, failure-free operation in demanding environments such as high-radiation, high-temperature, high-pressure, and caustic-fluids. An integrated engineering approach permits close interactions among the scientists, modeling and analysis personnel, and engineering and technical personnel experienced in optical, electrical, and mechanical and fabrication. NIS-4 has developed more than 400 instruments and systems from design to completion in the past 15 years.

Electrical engineering capabilities include the design, simulation, validation, and development of both analog and digital circuits employing state-of-the-art application-specific integrated circuits (ASICs), field-programmable gate arrays (FPGAs), and microminiature packaging technologies for optimal speed/noise performance. Extensive use is made of computer-aided design (CAD) software in design, analysis, and simulation to minimize loss of time and resources caused by design changes.

Mechanical engineering staff within the group develops lightweight, stable structures for applications from deep space to deep within Earth's interior, operating under severe environmental conditions. The design process includes appropriate structural and thermal analyses and tests to validate designs and verify the integrity and survivability of the system.

Optical engineering expertise includes the design, specification, and layout of optical elements for photonic systems dealing in wavelengths from ultraviolet light through long-wave infrared light, development of system alignment techniques and fixtures, and calibration and alignment instrumentation to verify optical system performance.

Technicians provide support to all aspects of instrument and system development. These include laboratory testing of concepts, design, fabrication, assembly, characterization and calibration, final acceptance testing, and *in situ* operation. Technical capabilities include electronics design, assembly and testing, optical assembly, alignment, mechanical machining and assembly, thermal-vacuum testing, vacuum-deposited coating, polymer mixing and application, and plastics and scintillating-material technology.

Launch scene of a payload on a Titan launch vehicle.

An NIS-4 employee works on the fabrication and assembly of an electronics circuit.

Safeguards Science and Technology (NIS-5)

Group Leader: **Avigdor Gavron**
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Deputy Group Leader: **Mark Pickrell**

An imaging gamma-ray spectrometer that uses a pinhole collimator and position-sensitive scintillator readout. This portable equipment consists of just the silvery horizontal cylinder (shielded detector with the pinhole collimator) and a portable computer. In a single count period, the system gives us a 2-dimensional map of the activity from a specific gamma ray. This allows us to determine the distribution of nuclear materials in two dimensions.

The Safeguards Science and Technology (NIS-5) group works to safeguard nuclear materials by developing techniques and systems for nondestructive assay (NDA) of nuclear and hazardous materials. Applications include nuclear materials control and accountability for domestic DOE nuclear facilities, nuclear waste disposal, material stabilization efforts, and international nonproliferation efforts.

The NIS-5 instrumentation and analysis technology measures nuclear materials by detecting and analyzing the neutrons, gamma rays, or heat given off by the material. NIS-5 instrument development begins with conceptual research and physics and proceeds through engineering to an industrial-quality, finished instrument. The analysis can be either active or passive. In active techniques, the nuclear material is bombarded with neutrons or gamma rays and the neutrons or gamma rays emitted in response are detected. Some nuclear materials produce sufficient quantities of neutrons, gamma rays, or heat to make a detectable passive signature. Analysis of the energies and intensities of these neutrons and gamma rays reveals the identity and quantity of the nuclear material. A measurement of the total heat output by calorimetry also provides a quantitative measure of the nuclear material.

NIS-5 has an extensive training program to teach methods of NDA measurement and analysis and provides more than 30 courses annually presented by experts in the field.

NIS-5 instruments and expertise are used for nuclear waste disposal, safety, and safeguards organizations within the US and throughout the world. The following are some examples:

- DOE Office of Safeguards and Security (NDA technology for nuclear materials accountability and inventory verification in DOE facilities)
- International Atomic Energy Agency (technology development and training)
- International nonproliferation technology (support for US bilateral safeguards collaborations to support the application of inspection technology)
- Russia, Kazakhstan, and the Ukraine (materials protection, control, and accountability interactions and training)

The following are some of NIS-5's areas of expertise and some specific projects:

- NDA measurement technology using neutrons and gamma rays (shufflers, passive and active neutron counters, tomographic gamma scanners)
- Integrated NDA systems for control and accountability of nuclear materials
- Continuous/unattended monitoring systems and information management analysis
- NDA training on gamma-ray, neutron, and calorimetry assay, holdup, and waste measurements
- Detectors and electronics development for portable measurements (miniature modular multichannel analyzer, CdZnTe gamma-ray detectors, and fast decay-time neutron detectors)
- Technology development for holdup, confirmatory measurements, and inventory verification (generalized geometry holdup technique)
- Experimental and computational physics and simulation for NDA technology (design of gamma-ray assay systems and neutron multiplicity counters)

As part of a joint measurement project, technical staff from Green Star Limited of Moscow, Russia, test a portable multichannel analyzer for use in the Joint US/Russia Material Disposition Program.

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Deputy Group Leader: **John C. Pratt**

Advanced Nuclear Technology (NIS-6)

The Advanced Nuclear Technology (NIS-6) group conducts nuclear criticality research studies that address national nuclear issues, trains various national groups in the use of nuclear instrumentation for assay and safe handling, and develops and calibrates nuclear radiation measurement equipment so it can detect and identify minute to sizable quantities of nuclear materials. In this work, NIS-6 uses a large variety of nuclear materials. The group's activities support basic research in nuclear chain-reacting systems and facilitate contributions to arms control and treaty verification, waste assay, safeguards and accountability, and environmental restoration.

NIS-6 operates the Los Alamos Critical Experiments Facility, a unique facility that contains the largest collection of nuclear critical-mass-assembly machines in the Western Hemisphere. These machines include the high-neutron-intensity burst assemblies Godiva-IV and Skua; the assembly machine Flattop, which is used in critical operations training; and the unique-solution critical assembly SHEBA (solution high-energy burst assembly). On other facility assembly machines, experimental configurations of various nuclear materials can be brought to a critical state for detailed testing of new concepts for nuclear materials behavior and for benchmarking computer models.

A key objective for NIS-6 is to teach Laboratory and DOE personnel how to safely handle and manage nuclear materials. NIS-6 staff give classes in criticality safety, dosimetry techniques, nuclear materials handling methods, and nondestructive assay instrumentation (for domestic and international safeguards and waste measurements).

One of NIS-6's major responsibilities is to train personnel, develop instrumentation, and provide technical expertise to the Joint Technical Operations Team (JTOT), formerly the Nuclear Emergency Search Team. NIS-6's nuclear research has led to the construction of deployable radiation detection monitors such as portable gamma-ray and neutron detectors that help assess potential terrorist threats.

For nuclear materials safeguards and accountability, waste assay, arms control, and environmental remediation programs, NIS-6 is developing and building a variety of instruments including the following examples:

- pedestrian and vehicle portal monitors,
- hand-held neutron and gamma-ray detectors,
- active interrogation and neutron correlation techniques to measure heavily shielded uranium and uranium in the presence of plutonium,
- instruments for neutron interrogation of packages for smuggling and customs border control stations,
- enrichment monitors for downblending of highly enriched uranium,
- combined thermal-epithermal neutron (CTEN) assay systems for radioactive waste in 55-gal. drums and crates, and
- long-range alpha detectors (LRAD) for monitoring personnel, equipment, soils, liquid and gaseous effluents, and radon.

NIS-6 operates a simulation facility in which nuclear materials can be configured to resemble nuclear devices. These mockups can be used to develop and validate instruments and methods used in nuclear nonproliferation work. Experimenters from across the DOE complex come to NIS-6's simulation facility to measure nuclear warhead components and triggers (pits).

NIS-6 participates in several aspects of the Nuclear Materials Protection, Control, and Accountability (MPC&A) program.

The CTEN instrument uses both thermal and epithermal neutrons from a 14-MeV pulsed source to measure milligram quantities of fissile material in radioactive waste drums.

SHEBA is the only operating solution reactor in the United States. It is used to simulate criticality accidents in solutions of special nuclear material. It is also used for neutron irradiation experiments such as the "accelerator production of tritium."

Safeguards Systems (NIS-7)

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Phone: 505-667-7777 Email: jprommel@lanl.gov
Deputy Group Leader: Joan M. Prommel

NIS-7 helps to define systems requirements and monitoring options for both domestic and international safeguards, such as this technical program dismantling pits from nuclear weapons.

The Safeguards Systems (NIS-7) group performs applied research and development to solve national security problems in domestic and international nuclear safeguards, arms control and transparency, and nonproliferation and terrorism involving weapons of mass destruction. In addressing these topics, the group engages in systems and policy analysis, information extraction, and information management. The group maintains a broad expertise in chemistry, physics, nuclear engineering, information analysis, computer science, and software development, and it has working knowledge of nuclear material process chemistry, nuclear facility operations, destructive and nondestructive measurement methods, as well as national security policy issues pertaining to fissile material, nuclear weapons reductions, and arms control.

NIS-7 develops tools that help detect clandestine production of weapons of mass destruction like this Iraqi effort to produce weapons-usable uranium.

Systems studies for nonproliferation analyze complex interactions between nuclear facility operations and verification technologies and procedures. The studies define technical and policy options for the implementation of nonproliferation regimes. Systems studies use unique modeling and simulation resources, optimization techniques, and decision-theory methods. Areas of development and capabilities demonstrated by systems studies include design and evaluation of domestic safeguards systems, design and evaluation of international verification systems, signature/indicator analysis, and policy support and analysis for the DOE.

Information extraction from large, complex data sets covers a broad area of algorithm development: data analysis, anomaly detection (identifying anomalies in safeguards information, satellite data, and review of video and sensor data), data fusion, trend analysis, classification, and automatic database assessment (using expert systems, neural networks, and statistical decision procedures).

Information management includes the development of nuclear material accounting software to help manage the world's nuclear material (incorporating the technologies of relational database design and graphical user interfaces), the use of open source information, and the storage and retrieval of large quantities of safeguards-relevant text.

NIS-7 provides services to many customers in the US government and the international community and applies its expertise to current and emerging challenges such as

- improved safeguards for fissile material accountancy and security at DOE sites,
- new approaches for nuclear safeguards under the International Atomic Energy Agency,
- bilateral or multilateral verification of possible cessation of fissile material production,
- materials control and accounting to help secure hundreds of tons of weapons-grade nuclear material in the former Soviet Union,
- safeguards for disposition of excess US plutonium and highly enriched uranium,
- verification of strategic arms reduction, and
- countering nuclear, biological, and chemical weapon terrorism.

Nonproliferation and International Technology (NIS-8)

Group Leader: **Ellen Leonard**
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Deputy Group Leader: **Jim Kowalczyk**

The Nonproliferation and International Technology (NIS-8) group analyzes international scientific research, development, and production issues related to the proliferation of weapons of mass destruction. NIS-8 seeks to deter proliferation of weapons-usable nuclear materials and the means to produce and use these materials by applying its scientific and engineering skills to designated problems. NIS-8 also provides information and analysis of critical technologies related to weapons of mass destruction by applying its scientific expertise to the problems and developing computerized information systems that allow rapid dissemination within the US government of accurate information needed for export control and policy decisions. NIS-8 also studies critical technologies that could impact the economic/environmental/military security of the US.

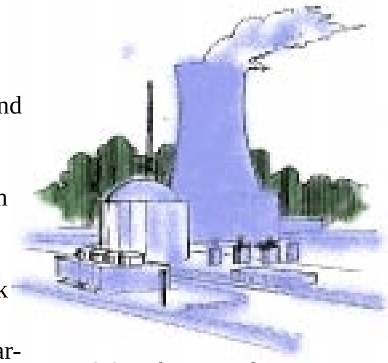
NIS-8 staff is expert in reactor and fuel cycle design; reactor safety systems evaluation; information and computer science; nuclear materials production processes; nuclear weapon design, production, and testing; photographic analysis; image enhancement; and political science and foreign languages.

NIS-8 plays a key role in analysis and assessment to support the former Soviet Union material protection, control, and accountability (MPC&A) interactions dealing with nuclear-related issues and technologies. NIS-8 is also the lead laboratory group in support of DOE's Office of Energy Intelligence (NN-30) programs concerning the evaluation of foreign stockpile stewardship/maintenance programs, the analysis of foreign nuclear infrastructures, the assessment of key stewardship technologies to support a weapons program, and the investigation of Comprehensive Test Ban Treaty-related issues.

NIS-8 is the lead organization for support to export control issues and activities of the DOE Nuclear Transfer and Supplier Policy Division (NN-43). NIS-8 provides technical support to the Nuclear Suppliers Group (NSG) and other national and international nuclear export control organizations. Such activities include

- determining those commodities needing control and assisting the US government in obtaining national and international agreements for such control,
- supporting the US government in export license case reviews,
- providing training on nuclear technology and proliferation issues for US government export control personnel,
- developing the Information Sharing System for the Nuclear Suppliers Group, and
- developing, installing, and maintaining the National Proliferation Information Network System to aid in export license processing and communication between DOE headquarters, DOE laboratories, and other agencies concerned with export control and nonproliferation activities.

A more recent activity of NIS-8 has been helping other nations—principally the Newly Independent States of the former Soviet Union—establish and administer controls on the exports of nuclear weapon commodities, technologies, and expertise. This program trains graduate students to act as facilitators in the former Soviet Union. Also, NIS-8 identifies and suggests collaborative scientific research and development opportunities with nations of the former Soviet Union.



NIS-8 evaluates nuclear facilities for the role they can play in a national nuclear program.

Nonproliferation training for customs officials in the former Soviet Union. Jim Munroe of NIS-8 is shown lecturing in Latvia.

Weapon Design Technologies (NIS-9)

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Deputy Group Leader: Thomas P. Suchocki

Chinese air-dropped nuclear weapon test in January 1972. China has made rapid progress in its nuclear weapon warhead development program in the move from fission-only weapons to thermonuclear warheads and subsequent deployments on operational delivery systems.

The Weapon Design Technologies (NIS-9) group has the principal mission to study and assess weapons of mass destruction programs in foreign countries using the collective expertise of the group and that of other Laboratory organizations. As part of this mission, NIS-9 is heavily involved in analogous studies of proliferant countries and their activities to achieve and enhance a nuclear weapons program. Other key parts of this mission area include nuclear weapon vulnerability assessments and real-time and technical support to US government emergency responses to nuclear weapon terrorism.

The group has diversified its capabilities into a variety of other key national security-related areas.

- Extension of capabilities to include other weapons of mass destruction, in particular chemical and biological weapons
- Directed energy weapons, such as high-power lasers, particle beams, and high-power radio-frequency weapons
- Nuclear weapon warhead missile system defense

An example of steganography research in NIS-9. Plain text is embedded in the white noise of this digitized image of one of NIS-9's outlying sites.

- Special technologies design and development to support the Intelligence Community, DOE, DoD, and DoD special operations forces
- Remote signatures collection technologies and analyses
- Technical support to international counter-terrorism organizations
- Information science and information operations

Remote signatures collection and analyses projects have included the detection and characterization of distant events across the electromagnetic spectrum, plus the audio spectrum. NIS-9 is also involved in the design and construction of the sensors to accomplish the detection of such events.

Our work in information science and operations is involved with numerous aspects of computer software, hardware, and small and large networks, including

- the vulnerability of information systems to various types of intrusions and attacks,
- the study of computer security issues and the enhancement of security via hardware and software techniques,
- information assurance assessments and techniques to increase the integrity of data on computers and data that pass over networks,
- application of software and hardware to remote sensing and collection projects,
- research into long-term data storage and data embedding, and
- encryption and decryption software studies and applications.

The approach to these studies is entirely based upon the application of science and technology by the members of NIS-9 and its consultants from other parts of the Laboratory. This is a vital component of overall government analyses supporting the US in its attempts to fully evaluate a foreign nation's military and political strategies, capabilities, and options.

The principal customers of NIS-9 in this mission area are the DOE's Office of Energy Intelligence (NN-30), the DoD, the national Intelligence Community, and the Department of State. Tasking and funding from agencies outside of the DOE require the approval of DOE NN-30. NIS-9 also provides intelligence data and assessments to Los Alamos National Laboratory managers and various Laboratory organizations.

Facility Management Unit-74

Facility Manager: Evelyn Mullen
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Facility Management Unit (FMU)-74 is a general purpose facility owned by NIS Division located at TA-18 and TA-36 that may be used for conducting static and dynamic experiments with fissionable material. The experiments may be conducted at subcritical, critical, or prompt critical. It is the home of the Los Alamos Critical Experiments Facility (LACEF), which has the largest collection of critical assembly machines in the Western Hemisphere, including both solution and burst machines. The research at this facility forms the general experimental basis for criticality safety practices and provides benchmark data to support nuclear physics computer codes.

Los Alamos Critical Experiments Facility/TA-18

Los Alamos Critical Experiments Facility (LACEF) operations are centered around three specially designed laboratory buildings, or kivas, that house critical assemblies with remote operation capability. In addition, each of the kivas contains its own storage vault where special nuclear materials are stored. An additional laboratory building is available for short-term use of special nuclear materials where "hands-on" measurements may be performed. The special nuclear material inventory of the facility includes a wide variety of material types and forms to meet varying programmatic needs.

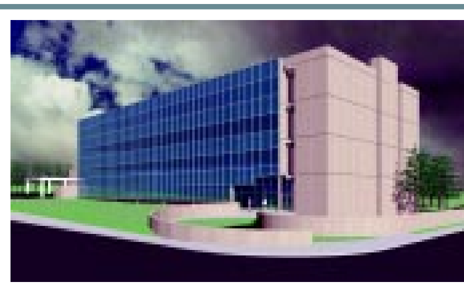
LACEF technical staff inspect core configuration of critical experiment for the mock-up of a compact nuclear power source (CNPS).

The facility also provides laboratories suitable for the development of radiation detectors. Linear accelerators, x-ray generators, and neutron generators may also be used at the facility for detector development and diagnostics. Some past applications of technologies developed within the facility have been in non- and counter-proliferation, safeguards, and treaty verification, as well as in stockpile management and stewardship programs.

NIS Division employs a facility manager and a team of facility management experts to assist tenants with authorization documentation, environment, safety and health issues, quality assurance, training management, facility maintenance, and waste management.

Los Alamos Nonproliferation and International Security Center: Planned Consolidation of NIS Activities

The process to consolidate NIS activities physically and organizationally near the Laboratory's hub has passed initial milestones and is supported by Laboratory and DOE management. Construction of a major new facility—the Los Alamos Nonproliferation and International Security Center (NISC)—will enhance program synergy and effectiveness by collocating the NIS nonproliferation, arms control, treaty verification, and intelligence functions near the scientific, technological, and information sources that support these programs.



The architect's rendering of the proposed NISC.

The new facility will house five of the nine groups, the three program offices, one FMU, and the NIS Division/Program office. Three other groups will be located in nearby existing facilities. Only the Center for International Security Affairs, because of its large number of foreign visitors, and NIS-6 (and the associated FMU), because of its special critical experiments facility, will remain in their somewhat remote, present locations. The new facility will accommodate just over 400 people in spaces designed for technical and administrative offices, light laboratory, light fabrication, special security, and support activities. It will support activities ranging in sensitivity from unclassified operations that may involve foreign nationals through top secret activities.

The facility will be approximately 164,000 ft^2, is estimated to cost $60 million, and is expected to be ready for occupancy in 2003.

Facility Management Unit-75

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Facility Management Unit (FMU)-75 is responsible for a multi-user facility composed of Technical Area (TA)-33, TA-66, several buildings at TA-3, and a defined portion of TA-35. TA-33 is located on State Highway 4 approximately seven miles from White Rock. This is one of the Laboratory's oldest active sites, dating back to 1947. This area has a history of interesting and varied scientific experimental uses that continue today. TA-33 houses several large buildings that have been renovated to permit open storage of classified material. This is also one of the most remote and largest sites at the Laboratory.

TA-66 is located on Pajarito Road, one of the Laboratory's newer buildings. This technical area houses the Center for International Security Affairs and the former Soviet Union MPC&A program offices. TA-35 is located on Pecos Drive approximately one mile northeast of Pajarito Road and 1.5 miles southeast of the intersection of Pajarito Road and Diamond Drive. The FMU-75 portion of TA-35 is not principally occupied by one division or group like many other technical areas, and it is considered a multi-user facility. FMU-75 manages several buildings in the TA-3 area, one of which is the Space Science Laboratory.

Space Science Laboratory

The Space Science Laboratory is a building designed specifically for the development and processing of high-reliability instrumentation. Special features include conductive floors and work surfaces to avoid electrostatic discharges, interior partitions that permit easy reconfiguration of the space, a small positive pressure to keep out airborne particles, two small conference rooms, and an isolated lunch room. Engineering services maintained by the facility include a hardware environmental coatings laboratory, a thermal/vacuum chamber instrument test capability, a laser laboratory for characterization and calibration of sensors, shop facilities for cable and printed board assembly, and an integrated network of industry and internal electronics and mechanical engineering computer-aided workstations.

Through this integrated network, unique engineering services such as high-density packaging design development integrated with private industry foundries permits an end-to-end process within the facility. Specific building areas were designed for all aspects of processing high-reliability and high-volume of hardware board assemblies. These processes include surface-mounting components, high-volume soldering, specialty cleaning, and oven baking. These areas were designed to comply with NASA and US Air Force specifications, as well as for the safety of personnel associated with soldering high volumes of hardware.

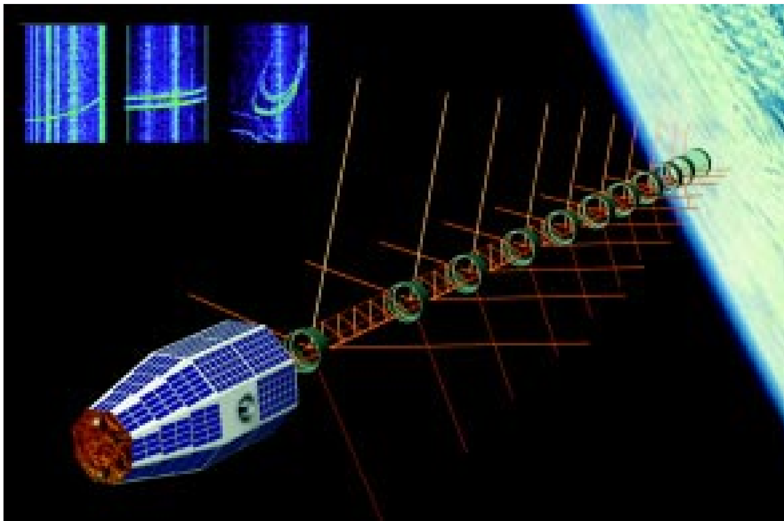
Space Science Laboratory

Extreme heat and cold testing is conducted on circuit boards using the thermal vacuum chamber.

The Thermal Vacuum Chamber Facility is designed to simulate space conditions of extreme hot and cold temperatures while under a vacuum.

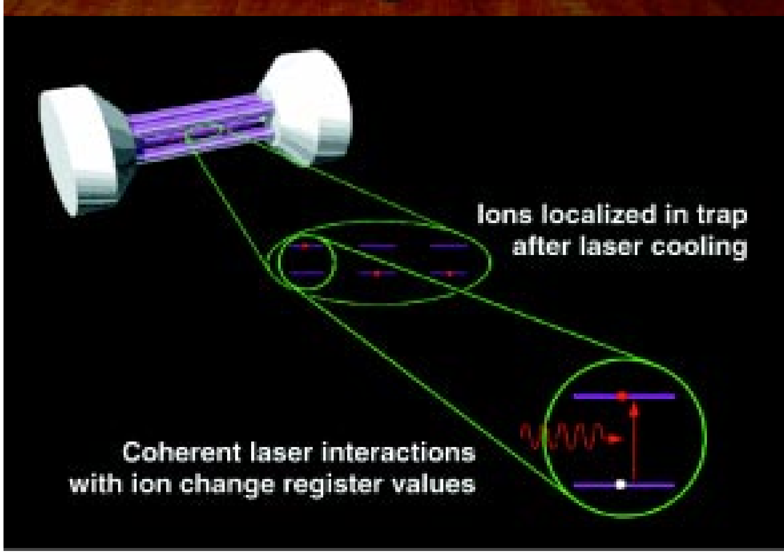
Vacuum-deposited coatings are performed to deposit thin coatings of metals onto other materials, to develop first-surface mirrors on various substrates, or to deposit thin conductive coatings to optical components. Included in the environmental coatings laboratory is the ability to apply protective coatings to metallic surfaces through an acid bath process, as well as polymeric coatings on electronic components.

1997 – A Year of Special Activities



The FORTÉ satellite was launched from Vandenberg AFB on August 29, 1997. The launch service and launch vehicle were provided by the USAF Space Test Program (STP). FORTÉ validates new technologies to improve our capability to verify the Comprehensive Test Ban Treaty. In particular, it will improve our ability to detect the electromagnetic pulse from a covert or clandestine test or use of a nuclear weapon. FORTÉ will also contribute to the scientific understanding of lightning and other electromagnetic phenomena of geophysical origin.

Los Alamos National Laboratory hosted, on behalf of NIS Programs, representatives from four major Russian nuclear institutes to discuss and demonstrate technologies related to monitoring warheads and warhead dismantlement. As a result of the meeting, eight contracts were signed between the Laboratory and Arzamas, Chelyabinsk, and the Institute of Automatics to develop technologies and procedures that could be used to monitor treaties involving warhead accountability and dismantlement. This work will be accomplished in 1998. In addition, several other areas were identified for future collaborations.



The Quantum Computing Initiative, a forefront research project sponsored by the NIS/IT Program Office, involves developing a quantum computer based on laser manipulations of cold, trapped calcium ions. Because the quantum computer would be able to perform many operations in parallel, it would have enormous computing power. This effort relies on the expertise of staff in several Laboratory organizations, including NIS Division.

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*Unclassified Mail Stop
**Classified Mail Stop

Additional information on NIS Division is available via the World Wide Web:
http://www.lanl.gov/external/organization/profiles/nis_profile.html

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Members of the Material Protection, Control, and Accountability Team won the Laboratory's Large Team Distinguished Performance Award in 1997.

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